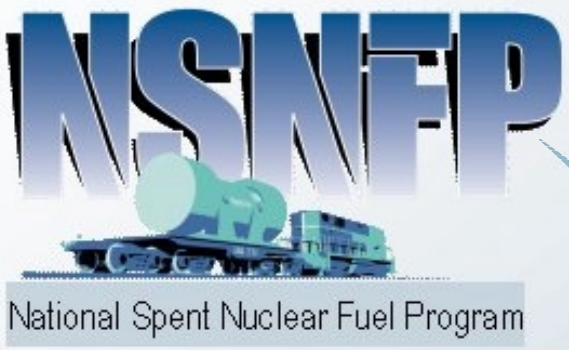


Container Systems R&D

Bill Hurt

Providing for safe, efficient disposition of DOE spent nuclear fuel

NSNFP Materials Development

- **Advanced neutron absorbing (ANA) structural alloys for DOE SNF canisters**
  - **Development team: INEEL, Sandia, & Lehigh**
- **Remote welding/NDE systems**
- **Effects and elimination of hydrogen inside packages**
- **Aging effects in 316L canister welds**
- **Effects of reactive fission products on container materials**

Gd-SS Effort - FY 2000

- **Identify alloy compositions and processes suitable for production of Gd-bearing SS**
- **Start with 316L matrix composition**
- **Use conventional ingot metallurgy/hot work**
- **Achieve an alloy with good weldability**
- **Identify alloy(s) suitable for ASTM endorsement and ASME Boiler and Pressure Vessel Code approval**

FY-00 Results

- Ingots were cast at compositions from 0.4-6 wt% Gd
- Hot forging was unsuccessful at 1060ºC due to liquation
- Hot work at 950ºC succeeded in providing wrought plate
- Gd-316L SS is expected to hot crack if welded
- Change to a nickel-base alloy should resolve issues

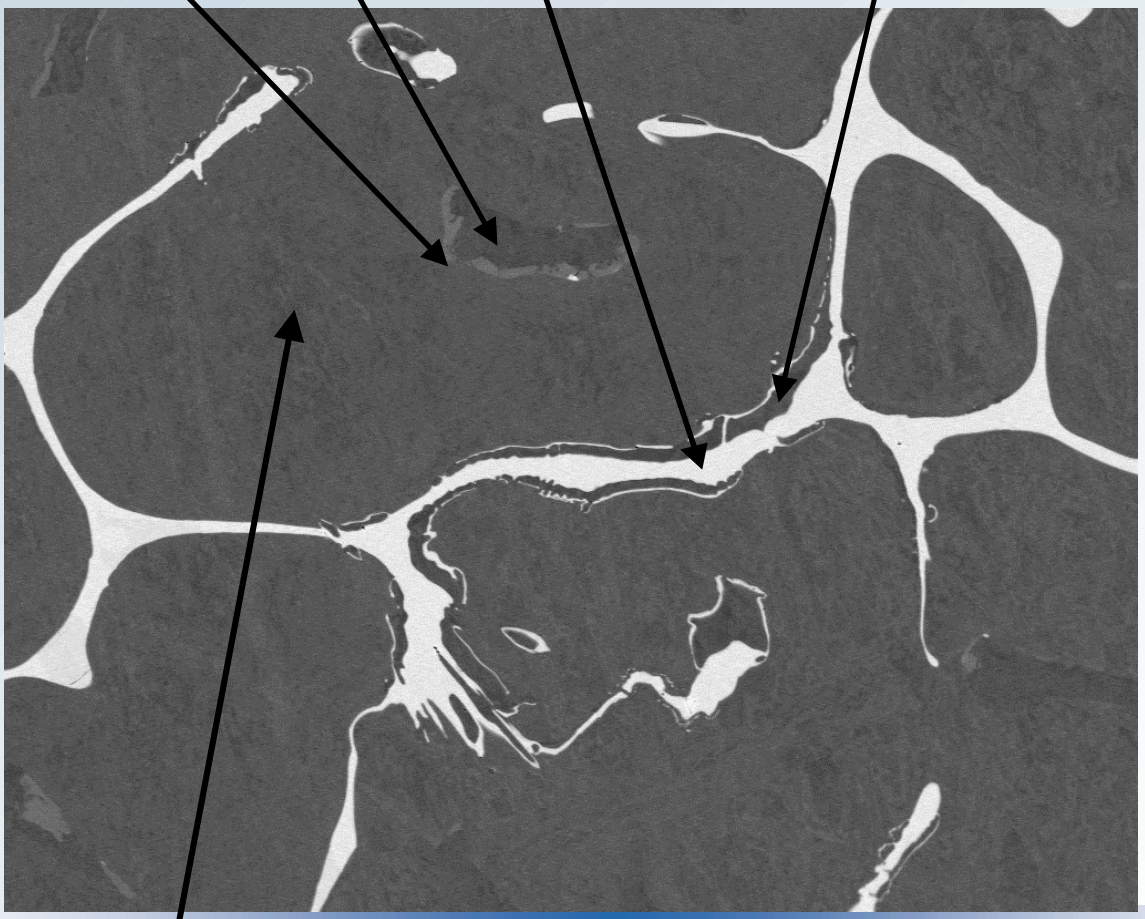
Mechanical Properties of Gd - SS Alloys

Alloy % Gd	Yield Strength ksi	Ultimate Strength ksi	Elongation %	Reduction of Area %	Impact Energy ft-lb
0	34.3	84.5	53	55	44
0.38	34.6	84.5	37	33	26
0.89	35.0	82.3	31	29	18
1.89	34.5	70.6	15	16	10

Conclusions - 316L-Gd

- **Microstructure is very sensitive to Gd concentration**
- **Alloying elements (Ni and Cr) must be balanced and impurities (e.g., S, P, O, Si) minimized**
- **Liquation of $(Fe,Ni,Cr)_3Gd$ phase during ingot breakdown at 1060ºC**
  - **Cannot be eliminated with heat treatment**
  - **Forging at 950ºC was successful but impractical**
- **Initial corrosion data show localized corrosion increases with increasing Gd**

Stainless Steel as-cast microstructures exhibit at least four phases: austenite, ferrite (in two places), sigma, and $(Ni,Fe\text{-}Cr)_3Gd$



BSE

The Plan - FY-01 to FY-03

- **Evaluate & test Ni-based alloy compositions:**
  - UNS NO6455 and NO6059, alloyed with 2% Gd
  - UNS N06022 with 3% Gd
  - Ni-Cr matrix with 2% Gd
- **Manufacture master heats for code tests**
- **Build alloy properties data set**
- **Provide repository corrosion and neutronics data**
- **Finalize Development**
  - ASTM Material Specification
  - ASME Code acceptance for welded construction
  - NRC acceptance
  - RW approval for DOE SNF canisters